SYSTEM AND METHODS FOR FLUID DELIVERY

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a Continuation of U.S. patent application Ser. No. 15/871,571, filed Jan. 15, 2018 and entitled Systems and Methods for Fluid Delivery, now U.S. Pat. No. 10,751,467, issued Aug. 25, 2020 (Attorney Docket No. W47), which is a Continuation Application of U.S. patent application Ser. No. 14/336,530, filed Jul. 21, 2014 and entitled Systems and Methods for Fluid Delivery, now U.S. Pat. No. 9,867,930, issued Jan. 16, 2018 (Attorney Docket No. M69), which is a Continuation Application of U.S. patent application Ser. No. 12/560,106, filed Sep. 15, 2009 and entitled Systems and Methods for Fluid Delivery, now U.S. Pat. No. 8,784,364, issued Jul. 22, 2014 (Attorney Docket No. G47) which claims priority from: U.S. Provisional Patent Application Ser. No. 61/097,021, filed Sep. 15, 2008 and entitled Systems and Methods for Fluid Delivery (Attorney Docket No. F72); U.S. Provisional Patent Application Ser. No. 61/101,053, filed Sep. 29, 2008 and entitled Infusion Pump Assembly with a Switch Assembly (Attorney Docket No. F73); U.S. Provisional Patent Application Ser. No. 61/101,077, filed Sep. 29, 2008 and entitled Infusion Pump Assembly with Tubing Storage (Attorney Docket No. F74); U.S. Provisional Patent Application Ser. No. 61/101,105, filed Sep. 29, 2008 and entitled Improved Infusion Pump Assembly (Attorney Docket No. F75); U.S. Provisional Patent Application Ser. No. 61/101,115, filed Sep. 29, 2008 and entitled Filling Apparatus and Methods for an Infusion Pump Assembly (Attorney Docket No. G08); U.S. Provisional Patent Application Ser. No. 61/141,996, filed Dec. 31, 2008 and entitled Acoustic Volume Sensing Methods, Systems and Apparatus (Attorney Docket No. G07); and U.S. Provisional Patent Application Ser. No. 61/141,781, filed Dec. 31, 2008 and entitled Split Ring Resonator Antenna Adapted for Use in Wirelessly Controlled Medical Device (Attorney Docket No. G81), all of which are hereby incorporated herein by reference in their entireties.

TECHNICAL FIELD

[0002] The present invention relates to the delivery of a fluid and more particularly, to systems and methods for fluid delivery.

BACKGROUND INFORMATION

[0003] Millions of people live with diabetes mellitus. These patients are further commonly classified into one of two types of diabetes, Type I and Type II. Type I, historically referred to as Juvenile Diabetes, is an autoimmune disease, and is characterized by the inability to secrete insulin. Type II is a disease that compromises the ability to respond to insulin and/or produce enough insulin. Both types of diabetes are characterized by hyperglycemia. Patient's living with Type I diabetes require multiple injections of insulin, a hormone that lowers blood glucose levels, everyday to survive. However, to maintain long-term health people living with diabetes strive to maintain as close to a "non-diabetic" blood glucose level as possible. Maintaining a healthy blood glucose level, however, is a very difficult goal to achieve.

[0004] To this end, there have been efforts to design portable devices, e.g. insulin pumps, for the controlled release of insulin. There are many different forms of insulin available. Most patients using an insulin pump currently use U-100 insulin rapid-acting insulin (e.g., HUMALOG insulin lispro injection or the like) in the pump. Insulin pump devices are known to have a reservoir such as a cartridge, syringe, or bag, and to be electronically controlled. However, the delivery rates must be manually entered by the person living with diabetes or a caregiver of that person. Thus, the diabetic patient determines/dictates the amount of insulin delivered for any given time/period of time (i.e., the "basal" and "bolus" rate/amount) using information or factors available to them, for example, their blood glucose readings determined using a blood glucose meter, past data from like situations, the food they intend to eat or have eaten, anticipated or previously completed exercise, and/or stress or illness.

[0005] However, although the diabetic patient determines the rate/amount based on one or more of these factors (or additional factors), managing diabetes is not an exact science. There are many reasons for this, including, but not limited to, inaccurate methods of delivery of insulin, inaccurate blood glucose meters, inability to correctly count carbohydrate intake, inability to determine approaching illness, inability to predict the exact effects of exercise, and the inability to anticipate or forecast the effect of many additional hormones or processes in the body.

[0006] The nature of managing diabetes is further complicated by the risk of hypoglycemia which may be fatal. Thus, over-calculating the amount of insulin required may be life-threatening. Short-term effects of hyperglycemia are not fatal; however, complications due to long-term hyperglycemia are known and include shorter life span, increased risk of heart attack or stroke, kidney failure, adult blindness, nerve damage and non-traumatic amputations. Thus, under-calculating the amount of insulin required may, in the long-term, substantially affect quality of life as well as lead to fatal complications.

[0007] Accordingly, there is a need for systems and methods for delivering the appropriate amount (i.e., the amount of insulin required to maintain a desired blood glucose level) of insulin at the appropriate time in a safe and effective manner.

SUMMARY

[0008] In accordance with one aspect of the present invention, a system for at least partial closed-loop control of a medical condition. The system includes at least one medical fluid pump. The medical fluid pump including a sensor for determining the volume of fluid pumped by the pump. Also, at least one continuous analyte monitor, and a controller. The controller is in communication with the medical fluid pump and the at least one continuous analyte monitor. The controller includes a processor. The processor includes instructions for delivery of medical fluid based at least on data received from the at least one continuous analyte monitor.

[0009] Some embodiments of this aspect of the invention include one or more of the following. Where the sensor further includes an acoustic volume sensor. Where the system further includes a network operation center, the network operation center in communication with the processor. Where the pump further includes a pumping chamber having an inlet connectable to provide fluid communication